Jim Annis

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Research Highlights . . .

DOE Pulse
Science and Technology Highlights from the DOE National Laboratories
Number 112 August 5, 2002

Fields of gold nanoparticles nodding in the sun

A smash radio hit in 1979 was a song about Californians "turning music into gold." In the California of 2002, scientists from the University of Texas-El Paso and Mexico produced work at the DOE Stanford Synchrotron Radiation Laboratory at the Stanford Linear Accelerator Center that showed alfalfa turning in the gold. More specifically, the researchers are using, as tiny factories, the alfalfa's natural, physiological need to extract metals from the medium in which they are growing. Of most value here is that the alfalfa extracts gold from the medium and stores it in the form of nanoparticles—specks of gold less than a billionth of a meter across. This may get the nanotechnologists humming a happy tune.

[Tom Mead, 650-926-5133, tmead@SLAC.Stanford.EDU]

Intruders beware

Computer software created by researchers at DOE's Idaho National Engineering and Environmental Laboratory lends its users watchful eyes. The program perfectly aligns pairs of digital snapshots—even those taken from different perspectives or with different cameras. By toggling between the two views, tiny inconsistencies between the images become readily apparent, providing an alert to alterations and possible trespass. "It would be very difficult to change something in one of the images without the software detecting the difference," said scientist Gregory Lancaster. In addition to physical security, INEEL scientists foresee a wide range of applications, from detecting cancer to forged signatures.

[Kendall Morgan, 208/526-3176, morgkk@inel.gov]

Sandia techs, bomb squads train for terrorist threats

Bomb-disablement experts from DOE's Sandia National Laboratories joined about 125 colleagues representing federal, state, and local agencies recently in a hands-on training conference sponsored by the Virginia State Police. Since 1992, Sandia's Chris Cherry and his Sandia team have developed some of the world's most technically advanced and widely used "render-safe" technologies. Operation America " is the honors program for bomb techs," he says. "We are proud to work with some of the country's best bomb squads to discuss and practice the art and science of disabling the increasingly complex terrorist bombs of today while protecting the lives of the public and our first responders."

[Howard Kercheval, 505/844-7842, hckerch@sandia.gov]

New institute will make ag wastes useful

Two DOE national labs and a pair of Northwest land grant universities are mobilizing to develop new methods for converting agricultural and food processing residue and wastes into commercially valuable "bio-based" energy and industrial products. Members of the new Northwest Bioproducts Research Institute include Pacific Northwest National Laboratory and Idaho National Engineering and Environmental Laboratory, as well as Washington State University and the University of Idaho. They will examine and develop methods for converting agricultural and food processing residue and wastes into bio-based fuels, power and industrial products, such as chemicals for plastics, solvents and fibers.

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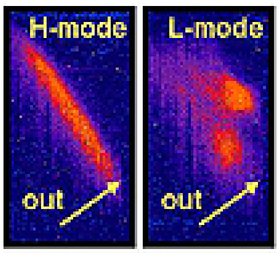
DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. ***DOE Pulse*** (www.ornl.gov/news/pulse/) is distributed every two weeks. For more information, please contact Jeff Sherwood (jeff.sherwood@hq.doe.gov, 202-586-5806).

Imaging system visualizes plasma turbulence

Researchers from DOE's Princeton Plasma Physics and Los Alamos National laboratories and the Massachusetts Institute of Technology have captured high-resolution images of instabilities that cause heat to leak rapidly from the plasma edge of the National Spherical Torus Experiment (NSTX) at Princeton and the Alcator C-Mod tokamak at MIT. Advanced imaging cameras developed by Princeton Scientific Instruments, Inc., under a DOE Small Business Innovative Research Project, were used to freeze plasma action at a rate of up to 1 million frames per second.



Sample images of edge turbulence in NSTX taken at 100,000 frames/sec. The plasma is highly turbulent in the Low-Confinement Mode (L-Mode), but relatively quiescent in the High-Confinement Mode (H-Mode).

NSTX and Alcator C-Mod are experimental devices used to study the magnetic confinement of plasmas—the hot ionized gases that serve as fuel for the production of fusion energy. In NSTX, instabilities emerge from the plasma edge at hundreds of meters per second. They appear as long filaments many meters in length, but only several centimeters thick. The filaments carry plasma energy and particles to the nearby vacuum vessel wall, causing a release of wall surface atoms, which in turn cool the plasma edge. When such instabilities are absent or much reduced, the plasma edge forms a barrier against heat loss, resulting in a steep rise in pressure at the plasma edge. The higher edge pressure in turn raises the core plasma temperature and density.

Images of the light emitted from a cloud of neutral helium atoms puffed into the plasma edge are shown in the illustration. The intensity of the light in the image on the right indicates that instabilities can fluctuate wildly in space and time. The left image shows light emitted when the instabilities are suppressed. These are the highest resolution images of the motion of edge turbulence in fusion research plasmas ever obtained.

Images of edge turbulence reveal a fascinating variety of shapes and motions, often taking the appearances of flickering flames, swaying aurora, or explosive flares on the surface of the sun.

Plasma physicists are studying the complexity and looking at the relationship between these plasmas and those found in space and on the sun. Progress will enable fusion researchers to determine the conditions under which the instabilities can be reduced or completely avoided for long durations.

Submitted by DOE's Princeton Plasma Physics Laboratory

FERMILAB'S ANNIS CONTEMPLATES A FLAT, LONELY UNIVERSE

Jim Annis

If Jim Annis is still alive in 100 billion years, he's going to be a lonely man.

That's when, if current universe-expansion theories are correct, most of the universe is going to be outside the event horizon—the point where no knowledge of events can be passed on. That means that as the universe expands and galaxies move farther and farther away from our own, even our most powerful telescopes will not be able to see anything beyond the stars of our own Milky Way and those of our closest neighbor, the Andromeda galaxy. Together, they have about 200 billion stars.

"And that's a small universe," Annis says. "We might as well be living inside a black hole."

As a member of the Experimental Astrophysics Group at DOE's Fermilab, Annis is in a pretty good position to talk about the universe. He has been at Fermilab for eight years, working mostly on the Sloan Digital Sky Survey. Scientists on the SDSS have the daunting task of mapping one-quarter of the sky—more than 100 million celestial objects—with more detail and precision than it has ever been mapped before. When it is all over they will have amassed about 15 terabytes of data, roughly equivalent to all the information in the Library of Congress.

Annis has been involved with SDSS since its planning stages, and was the person who pressed the button to take the experiment's very first data in 1998.

With the information they gather, SDSS scientists hope to better understand a number of mysteries, including the origin and evolution of galaxies; the structure of our own Milky Way galaxy; and the relationship between dark and luminous matter. They have already been able to figure out the shape of the universe: it's flat, not curved, as once thought.

"By analyzing large-scale sky surveys," Annis says, "we're trying to understand the main constituent of the universe—dark matter—and the main energy constituent of the universe—dark energy. Right now, we know very little about dark matter and even less about dark energy."

Submitted by DOE's Fermi National Accelerator Laboratory